Vol. 1 MAY, 1922 No. 5

JOURNAL

OF THE

AMERICAN WELDING SOCIETY

Published by the American Welding Society
33 West Thirty-ninth Street, New York

American Welding Society

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American Bureau of Welding

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JOURNAL

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AMERICAN WELDING SOCIETY

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AMERICAN WELDING SOCIETY

ESTABLISHED 1919

JOURNAL

VOL. 1 MAY, 1922 NO. 5

ANNUAL MEETING OF THE AMERICAN WELDING SOCIETY ONE OF THE MOST SUCCESSFUL EVER HELD

The annual meeting of the American Welding Society was one of the most successful ever held if accomplishments are taken as a criterion. The committees of the American Bureau of Welding have been unusually active in aiding the scientific advancement of the industry. Local sections are now formed in eight large cities, others are in the process of organization in various industrial centers throughout the country to assist in the work of the society. Keen enthusiasm has been shown in all of the sections and most of them are now holding regularly monthly meetings.

Owing to the business depression, the American Welding Society, as well as all the other technical and semi-technical societies, has been obliged to drop a large number of delinquent members. However, our own society has been fortunate in being able to replace most of these by new members. The financial question is still a serious one but even this is possible of solution, as pointed out elsewhere by the treasurer of the society, if all members aid in securing new members and advertising for the Journal.

The society has now established its own publication, which is receiving the enthusiastic support of the entire membership. In commenting upon our Journal, "Mechanical Engineering," which is the official organ of the American Society of Mechanical Engineers, states that "The American Welding Society is to be congratulated upon its enterprise in developing this medium of communication with its membership. Its form is readable, attractive and dignified."

C. A. McCUNE ELECTED PRESIDENT AMERICAN WELDING SOCIETY

At the annual meeting held on April 27th, Mr. C. A. McCune was unanimously elected president of the society for the coming year. As pointed out by the retiring president, Mr. S. W. Miller, Mr. McCune needs no introduction to the American Welding Society as he is known from Boston to San Francisco.

Very few of our members realize, however, the amount of time Mr. McCune has given to the society and the part he has played in making it a success. Like all modest men he works in a quiet way. Through his efforts as Chairman of the Membership Committee, the society has been literally lifted from one of the very smallest societies to one of a fair degree of prominence. Time and again Mr. McCune has, in a trying situation, stepped in and saved the day. It seems necessary in a new society like ours where there are many ideas as to how its affairs should be run that difference of opinion should exist. To co-ordinate the efforts of all workers into pulling together for the common good has been one of the chief aims of our new president elect. It is no wonder that we all feel that with Mr. McCune at the helm, our efforts for the coming year will be productive of good results.

ANNUAL DINNER

The first annual dinner of the American Welding Society, which

was held Wednesday afternoon, April 26th, was well attended. The picture shown elsewhere in this Journal tells better than words of its success.

PROFESSOR C. A. ADAMS AND MR. EDMOND FOUCHE ELECTED HONORARY MEMBERS OF THE AMERICAN WELDING SOCIETY

At the annual meeting of the society Professor C. A. Adams and Mr. Edmond Fouche received one of the highest honors that the American Welding Society can bestow, namely that of honorary membership.

In proposing Professor Adams for this honor Mr. R. E. Wanamaker stated that the founder of our society, Professor C. A. Adams, had the vision, the courage, the conviction and the perseverance to place before the people so that they could understand, the possibilities of this newly developed autogeneous welding process which is now recognized as one of the greatest mechanical devices of today.

In speaking of Mr. Edmund Fouche, Mr. H. S. Smith, stated that he was the inventor of the first oxy-acetylene blow pipe and the first who actually performed oxy-acetylene welding. Mr. Fouche is undoubtedly the pioneer of oxy-acetylene and gas welding.

As a symbol of this honor Professor Adams and Mr. Fouche received a gold emblem of the society. The same insignia was given to our first and other Honorary Member, Professor Elihu Thomson, inventor of the Electric Resistance Welding Process.

FOUR EXCELLENT PAPERS PRESENTED AT TECHNICAL SESSION OF THE AMERICAN WELDING SOCIETY

At the technical session of the Society held on April 27th the following papers were presented: "Welding of Heavy Copper Plate," by A. S. Kinsey; "Electric Welding of Dredge Pipes," by J. H. Nead and R. L. Kenyon; "Notes on the Occurrence and Influence of Non-Metallic Inclusions and Cavities in Electric or Oxy-Acetylene Deposited Metal," by R. O. Griffis; and "Recent Researches in Thermit Welding," by J. H. Deppeler. These papers were well received and it was the consensus of opinion of those present that they constitute a valuable contribution to the advancement of the welding industry.

REPORT OF TELLERS COMMITTEE

In addition to the election of Mr. C. A. McCune as President of the Society the following officers were elected to serve for the coming year:

Vice-Presidents: W. H. Namack, New York and New England District; T. F. Oechsle, Middle Eastern District; W. A. Slack, Middle Western District.

Directors at Large: James Burke, Hermann Lemp, H. I. Walsh, A. F. Jenkins.

BOARD OF DIRECTORS MEETING

At the Board of Directors meeting, held on April 27th, the following appointments were made:

W. E. Symons, re-appointed as Treasurer and Chairman of the Finance Committee.

Miss M. M. Kelly re-appointed Acting Secretary.

Mr. L. B. Mackenzie, Chairman of the Membership Committee.

Mr. A. G. Oehler, Chairman Meetings and Papers Committee.

Mr. H. Lemp, Chairman of Revision of By-Laws Committee.

A fairly large Executive Committee was appointed by the incoming President with the aid of the Board of Directors. This Executive Committee is as follows: C. A. Adams, J. H. Deppeler, A. S. Kinsey, S. W. Miller, E. M. T. Ryder, H. S. Smith, W. E. Symons, and C. A. McCune, Chairman.

First Annual Dinner American Welding Society, Reisenweber's, New York City, April 28, 1922.

TREASURER'S REPORT FOR YEAR ENDING MARCH 31st, 1922

To Members of the American Welding Society:

Agreeable to the expressed wish of members at our Annual Meeting, held in New York City, April 26, 27, 28, 29, 1922, I present herewith copy of report submitted at the meeting, with such supplemental data or comments as I feel may be essential to a clear and comprehensive presentation of the financial status of the Society. I will first invite your attention to Exhibit A, receipts and disbursements for fiscal year ending March 31, 1922.

AMERICAN WELDING SOCIETY
EXHIBIT A

Statement of income and expenses for fiscal year ending March 31, 1922:

RECEIPTS (Deposited)

Average number members, 1921-2, 650

Dues	$7,982.50	
Pins	54.47	
Bulletins	38.77	
Journal subscriptions	44.00	
Binders, papers, etc	34.15	
Miscellaneous (cards, refund on room, etc.)	20.90	
Interest	42.11	
		$8,216.90

RECEIPTS (Not Deposited)

Dues (refunded to Philadelphia Section to cancel debt	$295.00	
Bulletins (paid for by stamps)	9.50	
Cancelled checks	13.50	
		318.00
Balance brought forward from year 1921		4,148.84
		$12,683.74

Total Income, $8,534.90 Average per member, $13.13

DISBURSEMENTS (By Check)

Salaries		$3,325.08	
Acting secretary	$1,920.00		
Stenographer	1,300.00		
Office help*	105.08		
Printing and stationery		1,527.31	
Rent (room and equipment)		1,194.00	
Maintenance (telephone, telegraph and stamps)		479.79	
Section refund		1,860.94	
Welding engineer		827.50	
Annual Meeting (1921)		162.36	
Meetings and Papers Committee		456.50	
Bulletins (Nos. 1 and 2)		95.00	
Journal		524.50	
Miscellaneous (auditing books, reporter)		267.00	
			$10,719.98

*From Feb. 20, 1922, to date; salary, $936.

DISBURSEMENTS (Not Handled Through Bank)

Retained by Philadelphia Section to cancel debt.	$295.00	
Stamps for Bulletins	9.50	
Cancelled checks	13.50	
		$318.00
Cash on hand March 31, 1922		1,645.76
		$12,683.74

Total expenditures, $11,037.98. Average per member, $16.89

EXHIBIT B

April 6, 1922.

American Welding Society,
33 West Thirty-ninth Street,
New York City.

Dear Sir: We have examined the cash records for the period beginning April 1, 1921, and ending March 31, 1922.

We find that these records are verified by the reports of the Bankers' Trust Co. and that the checks for disbursements are as indicated on the cash records.

The total receipts were	$8,216.90
The disbursements were	10,719.98
The balance on hand is	1,645.76

We have made some suggestions as to changes in the methods of keeping the books, which we think will more clearly record the transactions and enable us to render a complete report for the coming year.

Very truly yours,
W. J. Struss & Co.

Note: At the treasurer's request this report was examined by a committee of the Society consisting of Messrs. Owens, Reed and Bates, and found to be correct.

EXHIBIT C

Estimated Budget, 1922-23

(April 1, 1922, to March 31, 1923)

INCOME		EXPENDITURES	
Number of members, 600		Return to Sections on membership—	
From membership dues—		Dues on paid members	$4,047.50
Paid members (Section members)	$8,095.00	Dues on delinquent members	720.00
Paid members (not in Sections)	1,465.00	Salaries	4,156.00
Delinquent members in Sections	1,440.00	Office rent	1,152.00
Delinquent members not in Sections	340.00	Telephone and petty cash	750.00
From advertising—		Miscellaneous	500.00
Estimated at $350 per month	4,200.00	Journal, estimated at $550 per month	6,600.00
	$15,540.00	Total expenditures	$17,925.00
Average per member	$25.90	Total income	15,540.00
		Deficit	$2,385.50
		Average per member	$29.87

SUMMARY

A careful study of this display will not only show clearly just what has been done with every dollar of your money during the past year, but will also impress one and all of the absolute necessity of both individual and team work in the matter of:

(A) Urging delinquent members to remit at once.
(B) Securing new members.
(C) Aiding in every way possible in the sale of advertising space in our Journal, to the end that our progress during the year may be such as to reflect much credit on the Society as such and on each member who, through his efforts, contributes to our success.

W. E. Symons,
Treasurer and Chairman of Finance Committee.

RESEARCH ACTIVITIES

AMERICAN BUREAU OF WELDING ELECTS SAME OFFICERS

At the annual meeting of the American Bureau of Welding, held on Friday, April 28th, the following officers were elected to serve for another year: Professor C. A. Adams, Harvard University, Director; H. M. Hobart, General Electric Company, 1st Vice-Director; A. S. Kinsey, Stevens Institute, 2nd Vice-Director; W. Spraragen, National Research Council, Secretary.

The only new activities undertaken for the coming year was the organization of a Committee of Tank Manufacturers to investigate problems arising in connection with the welding of pressure vessels. The progress made by the present ten research committees was considerable as is indicated by the several reports given elsewhere in this issue.

The American Bureau of Welding is beginning to fill a long felt need for an unbiased authority on the many questions arising in connection with this new art. Of these questions some refer to regulatory and safety legislation, some to the training of welders and some to the technique of welding. Answers must be based upon the fundamental, scientific facts.

Problems arising in the industry are now regularly referred to the bureau for solution. Numerous investigators and laboratories are cooperating in the work. Its connection with the National Research Council has been one of the greatest aids in securing this cooperation. The bureau has no funds of its own and there are no salaried officers or assistants. Stenographic facilities and other office expenses are largely provided by the American Welding Society and National Research Council.

ELECTRIC ARC WELDING COMMITTEE MAKES PROGRESS

The fifth meeting of the Electric Arc Welding Committee was held on April 28th and was well attended. Some of the important problems taken up at this meeting were cast iron welding, welding of monel metal, application of welding to shipbuilding abroad, standards for arc welding machinery, locked-up stresses, enameling arc fused metal and welding of copper and brass.

Mr. Namack, Chairman of the Sub-Committee on Cast Iron Welding, stated that the first part of the summary dealing with the general properties of cast iron and the effect of each element on weldability is finished. The portion dealing with electric arc welding of cast iron is well under way. This part includes general discussion of preheating, problems and methods of metallic arc welding, shrinkage difficulties, theory of use of steel studs and proper welding procedure when using studs, hardness of weld, insertion of copper strips, reverse polarity, special electrodes, carbon arc welding of cast iron and a program of research on those problems needing further investigation. Dr. P. D. Merica of the International Nickel Company described the use of metallic deoxidizer in welding monel metal. Mr. E. H. Ewertz, General Manager of the Moore Plant, Bethlehem Shipbuilding Company, gave an interesting account of the progress made in England on the application of welding to shipbuilding. Mr. W. Spraragen reported that the Standards for Arc Welding Machinery will soon be published in the Journal of the American Welding Society. Considerable progress has been made determining which type joint reduced locked up stresses to a minimum and attention is now being devoted to devise some method of determining experimental methods for measuring locked-up stresses in welded joints. Both Mr. R. E. Wagner and Mr. Eschholz exhibited samples of heavy copper welding with carbon arc and special electrodes. The latter also exhibited samples of successful enameling of arc-fused metal.

COMMITTEE ON TRAINING OF OPERATORS HOLDS INTERESTING MEETING

Work on the drawing up of a course for the Training of Operators is well under way. Consideration has been given to the proper items to consider in dealing with the qualifications for welders. Some of these are age, temperament, muscular co-ordination, vision and history of experience. Suggestions have also been advanced for methods of testing applicants claiming to be welders.

In the part dealing with the fundamentals of welding, there will be considered, welding equipment, protection, electrode and torch manipulation, arc and flame characteristics, fusion characteristics, residual stresses, welding procedure, terminology and exercise jobs. Checking levels, under which will come typical jobs, will be made for determining the progress made by the student welder.

RESISTANCE WELDING COMMITTEE MAKES CONSIDERABLE PROGRESS

Owing to the financial and industrial conditions of the country, no meetings were held by the Committee since the last annual meeting of the Society. The work mapped out while apparently dormant was, however, carried on by active workers through correspondence. At the meeting of the Committee on Thursday, April 26th at the Engineering Societies Building the following reports were presented:

1—Sub-Committee on Standardization —W. C. Moody, Chairman.

The task allotted to this committee was to arrive in conjunction with the Standards Committee of the A. I. E. E. at the uniform rating of Resistance Welding Machines for butt, spot, seam and percussive welding, and of making rules that would be equitable to the three predominating interests; namely, the users, manufacturers of welding apparatus and the central station man furnishing the energy. In this correction it was brought out that an electrical resistance welding machine may be looked at from two different view points: (a) As a transformer, pure and simple; (b) as a translating device fed from a service transformer. Under the first interpretation, the A. I. E. E. Rules regarding transformers by determining its performance through electrical output would have to be observed. Under the second interpretation, the output would be determined by the welding output and the electrical energy by the input. The Committee accepted the second interpretation as the more practical one (subject to confirmation by the Standards Committee of the A. I. E. E.) and instructed the Sub-Committee on Standardization to rewrite its recommendations on this basis. This report, after re-submission in writing to the members of the Committee on Resistance Welding will be forwarded to the Secretary of the American Bureau of Welding.

2—Sub-Committee on Nomenclature —Malcolm Thomson, Chairman.

A very complete report was submitted by the Chairman at this meeting. A discussion brought out suggestions for a few minor alterations which will be incorporated in the report before it is finally submitted to the Bureau.

3—Sub-Committee on Present State of the Art of Butt Welding—W. Remington, Chairman.

A lengthy and very thorough report was presented and the members of the main Committee were asked to read it carefully and forward any comments before it is formally presented to the American Bureau of Welding.

4—Sub-Committee on Present State of the Art of Seam Welding—H. W. Tobey, Chairman.

A similar action to that taken in connection with the Summary on Butt Welding was taken regarding the complete report presented and read by the Chairman of the Sub-Committee on Seam Welding.

5—Sub-Committee on Spot Welding.

A draft was submitted by Mr. Remington, which will be enlarged and revised.

6—Sub-Committee on Review of Percussive Welding—D. F. Miner, Chairman.

A very complete report with several illustrations was presented by the Chairman and accepted with minor suggestions. This report will be published in a early issue of the Journal as a paper by Mr. D. F. Miner.

7—Research Recommendations.

A list of special subjects worthy of research contributed by various members was read and it was suggested that this list be submitted to the members of the Committee in order that each might express their preference in writing as to the order of importance of researches to be undertaken. In this connection, it was brought out that researches dealing with fundamentals and which would not get into patentable fields should be listed first.

PLANS MADE TO ORGANIZE A COMMITTEE OF TANK MANUFACTURERS

A conference of Tank Manufacturers was held on Wednesday, April 26th in the Engineering Societies Building, under the auspices of the American Bureau of Welding to formulate plans for the organization of a Committee to adequately deal with the welding problems in connection with the construction of unfired pressure vessels. The purpose of this Committee is primarily to assist the Boiler Code Committee in drawing up a suitable Code for the welding of such vessels.

Professor C. A. Adams, Director of the Bureau, opened the meeting with some introductory remarks on the purpose of the Conference, needs for organization, plans for conducting the work, and indications of possible cooperation and financial contributions. He was followed by Mr. S. W. Miller who delivered a brief address on the value of the work and a similar example of cooperation in the malleable casting field. Mr. Miller stated that in the early days of the malleable casting industry everything was done by rule of thumb, based on practical experience, with a result that in the course of time malleable iron was looked upon by the purchaser as an unreliable, irregular product, no two shipments of which were the same and whose use he was compelled to abandon because of the impossibility of getting consistent and safe results. As a last resort the manufacturers got together, organized an association and employed an expert Metallurgist. As a result of the improvement brought about in the product by the research work of this organization, malleable iron is now one of the most widely used foundry products. Mr. Miller stated that in many respects the welding industry is today in somewhat the same position as was the malleable iron industry a number of years ago.

The attitude of the Boiler Code Committee toward autogenous or fusion welding in pressure vessel work was brought out in the following statement of a preliminary report issued Dec. 5, 1921:

"The Boiler Code Committee recognizes the advance that is being made in autogenous welding and wishes to encourage progress and improvement. Advance should, however, be made in a way that will not endanger life or property, and it is the duty of the Boiler Code Committee in issuing any rules to make sure they are safe. It would seem highly desirable to lean toward the side of safety in bringing out rules for a new and growing industry with the idea of broadening out the rules as the art advances, rather than to reach out too far at the start with the risk of accidents that might set back its development."

The viewpoint of insurance people was brought out by Mr. S. F. Jeter who stated that while the insurance people had no antagonistic views towards welding, it was impossible to differentiate in insurance rates on pressure vessels by different companies or individuals. They are compelled to lay down rules which, if followed, all can get by on, and if they

are not followed, they cannot get by. Moreover, the insurance people must safeguard the Public by not offering protection on vessels that are not reasonably safe.

It was the consensus of opinion of those present that an Organization Committee should be appointed to devise ways and means for setting up an organization of manufacturers of pressure vessels to deal with the situation at hand. The following members were appointed to act upon this committee: L. Doelling, De La Vergne Machine Co.; F. F. Couch, Brunswick Refrigerating Co.; C. A. Adams, Director, American Bureau of Welding; S. W. Miller, Rochester Welding Works; W. Spraragen, Secretary, Engrg. Div., National Research Council; G. H. Lane, York Manufacturing Company; A. T. Snow, John Wood Manufacturing Company; E. P. Poste, Elyria Enamel Products Company; F. T. Flocke, The Vilter Manufacturing Company; George A. Sims, The Sims Company; W. B. Miller, Pfaudler Company.

Mr. Doelling was appointed Chairman, and Mr. W. Spraragen, Secretary.

COMMITTEE ON SPECIFICATIONS FOR STEEL TO BE WELDED STARTS RESEARCH PROGRAM

A very successful meeting of the Committee on Specifications for Steel to be Welded was held in New York on April 27th. A report was submitted by Messrs. J. H. Nead and R. L. Kenyon, illustrated by lantern slides and samples giving results of preliminary tests to investigate several methods which have been proposed as a means of distinguishing between suitable and unsuitable material to be welded, i.e., plates, sheets, angles and other structural forms. Three different methods were employed in these experiments:

(1) Heating electrically to fusion.

(2) Heating by Oxy-Acetylene to fusion.

(3) Baking on a vitreous enamel by heating electrically.

In all cases the idea followed out was that suitable materials are well degasified and fuse quietly while unsuitable materials are largely those not gasified or at least only partly so and therefore fuse with gas evolution and more or less effervescence, sparking, bubbling, spattering, etc. It was the consensus of opinion that the results of these tests indicated possible methods for determining the weldable qualities of iron and steel and that further investigation was necessary in this direction to determine the reliability of these tests. It was suggested in this connection that physical tests be made in parallel with the proposed weldability test. Several companies volunteered to make the investigations and representatives of the steel companies present promised to furnish the steel samples.

EMPLOYERS, ATTENTION

WE HAVE IN OUR FILES THE RECORDS OF MEMBERS WHO HAVE HAD FROM ONE TO FIFTEEN YEARS' EXPERIENCE IN THE WELDING FIELD. IF YOU NEED ANY WELDING TALENT, KINDLY LET US KNOW. THIS SERVICE IS FREE.

A-9—Experienced electric welder desires position. Have had about 6½ years of experience in this field, covering ship construction, marine boiler repairs, tank welding, pipe line welding, locomotive welding and street railway work. For past year have been employed by Third Avenue Railways System. Have also worked for Atlantic Basin Iron Works, Quasi Arc Weldtrode Company, Electric Welding Company of America and W. J. Kennedy Company. Can furnish references.

SECTION NEWS

CLEVELAND SECTION HOLDS ANNUAL MEETING

At the annual meeting of the Cleveland Section, the following officers were elected: Chairman, C. F. Eberhardt, Eberhardt Welding Company; First Vice-Chairman, R. S. Sawdey, Van Dorn Iron Works Co.; Second Vice-Chairman, John H. Thornton, David Lupton's Sons Co.; Secretary and Treasurer, Henry Spero, Brown Advertising Service.

Mr. Breckenridge of the National Tube Company presented a paper, written by Mr. F. N. Speller, on "Steel for Forge Welding." This paper was illustrated by lantern slides and motion pictures.

ORGANIZATION OF LOS ANGELES SECTION OF THE AMERICAN WELDING SOCIETY

The first meeting of the Los Angeles Section, for the purpose of election of officers, was held on April 15th. The following officers were elected: Chairman, L. J. Smith, Pacific Electric Railway; Vice-Chairmen, B. H. Eaton, Los Angeles Railway Co; J. H. Cunningham, General Electric Co.; Secretary, E. W. Crane, Wilson Welder & Metals Company; Treasurer, S. Barton Brown, Equitable Welding Company.

Mr. J. C. Coberly gave a very interesting talk on Acetylene and its production and was followed by Mr. E. W. Crane with a few remarks on arc welding. There is a strong feeling in this locality that the Los Angeles Section will be of considerable benefit to the advancement of welding as there is quite a movement towards industrial manufacturing and of fabrication of steel and iron products.

NEW YORK SECTION TO HOLD MEETING ON MAY 16TH

The regular monthly meeting of the New York Section was held on May 16th. A paper on "The Use of Metallic Deoxidizers in Arc Welding with Monel Metal" was presented by Dr. P. D. Merica of the Research Department of the International Nickel Company. This was followed by a discussion of a paper by Mr. Harmiishi "On the Application of Electric Arc Welding to Two Vessels," which was published in the February issue of the Journal.

NORTHERN NEW YORK SECTION ELECTS NEW OFFICERS

At a meeting held on May 2nd, the Northern New York Section elected the following officers for the coming year: Chairman, J. A. Seede, General Electric Company; First Vice-Chairman, J. Weis, New York Central Railroad Co.; Second Vice-Chairman, S. R. Stockholm, Troy Welding Company; Secretary, D. H. Deyoe, General Electric Company; Treasurer, E. W. Bradford, American Locomotive Company.

ANNUAL MEETING OF THE PHILADELPHIA SECTION

The annual meeting of the Philadelphia section was held on April 19th. Moving pictures on "The Making of a Saw," were shown by Henry Disston & Sons, Inc. The following officers were elected for the coming year: Chairman, T. F. Oechsle, David Lupton's Sons Company; First Vice-Chairman, Col. Royal Mattice. Mattice Engineering Company; Second Vice-Chairman, Dr. H. S. Lukens, University of Pennsylvania; Secretary, A. Schroeder, Standard Electric Welding Company; Treasurer, Clifford W. Bates, Philadelphia Electric Company.

SAN FRANCISCO SECTION HOLDS MEETING ON MAY 4TH

The May meeting of the San Francisco Section was held at the Engineers Club on May 4th with 45 present. A paper on "Welding as Practised on the Santa Fé System" was presented by Mr. H. A. Patterson, Foreman Welder of the Richmond Shops of the Santa Fé Railroad. Mr. Patterson's paper was interesting and instructive and brought out an extensive discussion.

THE USE OF METALLIC DEOXIDIZERS IN ARC-WELDING WITH MONEL METAL*

By P. D. MERICA and J. G. SCHOENER

The welding of Monel Metal by the oxy-acetylene torch has never presented any particuar or unusual difficulties, such, for example, as would not be presented by steel under the same circumstances. Rods, sheet and castings of Monel Metal are regularly welded by this method and sound, strong and moderately ductile welds obtained. Although the practice in such welding is not essentially different from that used with steel, detailed instructions are issued by The International Nickel Company, manufacturers of this alloy, for the oxy-acetylene welding of Monel Metal in all forms.

Attempts to arc-weld this metal have hitherto not proven similarly successful, whether by the carbon or the metallic arc method. In such trials the general experience has been that it is difficult to produce consistently, welds which are sound and free from blowholes, ductile and free from shrinkage cracks.

Inasmuch as the arc-welding method offers in many cases the advantage over the oxy-acetylene one of lower cost, the Research Department of The International Nickel Company has for the past six or eight months been engaged in an effort to develop satisfactory arc-welding practice for the metal. The particular objective sought was to develop a method of producing sound and ductile welds, free from cracks.

The Welding Properties of Monel Metal

It is now generally recognized among those expert in welding that the behavior of a metal in the foundry; i. e., in being melted, poured and cast in a chill or sand mold throws light on its behavior during welding as, of course, would be expected. A weld is but a chill casting frozen to its mold. This viewpoint has proved particularly useful in the case of Monel Metal.

When this metal (in its virgin form free from manganese) is melted and brought to the correct "pitch"; i. e., such that it has the right carbon content, which varies according to the use from 0.10 to 0.30%, a casting poured from it either in a chill or in a sand mold will in general neither be malleable, ductile nor free from blowholes. The addition of ferro-manganese or metallic manganese together with about 0.1% of metallic magnesium will, however, "deoxidize" the molten metal and a casting or chill bar or ingot poured subsequently will be both sound and ductile.

It seemed apparent from consideration of the first difficulties encountered in arc-welding that the metal melted by the arc absorbed sufficient oxygen from the surrounding air that it required re-deoxidation in order to make it again malleable and sound. It may be observed that special deoxidation is not necessary in oxy-

*Presented at the May 1922 meeting of the New York Section, A. W. S.

acetylene welding because the operator uses a reducing flame which protects the hot and molten metal from the air.

This view has been confirmed by subsequent tests and we have definitely ascertained that just as Monel Metal must be "deoxidized" before casting into sand molds and ingots so must it be also "deoxidized" in producing satisfactory arc-welds. And the agents which are found to be superior for this purpose are the same as those used in the foundry; viz., magnesium, manganese and silicon, in the order of their importance for this operation.

Deoxidation During Welding

We have found that these agents are best employed in the form of alloys, ground to from 50 to 100 mesh and applied to the welding rod of bare Monel wire as a thin coating. It is obvious that the alloys used for this purpose must be sufficiently brittle and preferably, also, soft, that they can be powdered. The binder which we have found entirely successful is very simply made up of denatured alcohol containing ½ lb. to the gallon of shellac. Other similar binders would undoubtedly serve equally well.

According to our experience the exact composition of this coating powder may vary within moderately wide limits, the essential

Fig. 1—Photograph showing section through arc weld using plain Monel wire electrode without deoxodiser coating. Numerous blow-holes present.

thing being to introduce into the welded metal about the amounts of manganese and silicon and particularly of magnesium which are generally used for deoxidation in the foundry. Thus we should introduce from 0.05 to 0.50% of magnesium, from 0.20 to 1.00% silicon and at least 0.20% of manganese; the upper limit of manganese is not important, as an excess is not harmful. An excess of magnesium or silicon, however, will tend to produce dirty or brittle metal respectively.

Preparation and Composition of Coating Powder

We have applied these coatings dry simply by making a suspension of the powder in the dilute shellac solution and dipping the wire into it and allowing it to dry. The coating can also be applied by brush, although at greater expense of time and with greater loss

of material. This coating we have found adheres well and will not be removed by packing and transportation. It will vary in thickness, but on a 5/32″ wire will run about a pound to 600 feet and approximately 2% by weight of the wire.

The alloys to be used in the preparation of the powder may vary widely when consistent only with the condition that all must be

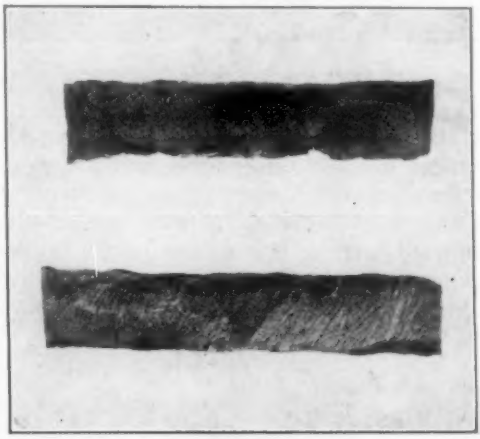


Fig. 2—Photograph showing section of arc welds using Monel wire with deoxidiser coating. Absence of blow holes should be noted.

powdered and that certain limits noted above as to magnesium and silicon content be maintained. We have had entire success using ferro-manganese or metallic manganese and one of the silicon-manganese-magnesium alloys produced by the Electro Metallurgical Company and having the following composition as described in their recent booklet:

	Grade No. 1 Per Cent	Grade No. 2 Per Cent	Grade No. 3 Per Cent
Magnesium	25 to 30	14 to 16	8 to 10
Manganese	20 to 25	27 to 33	45 to 50
Silicon	35 to 40	45 to 50	40 to 45
Carbon	Max. 0.20	Max. 0.20	Max. 0.20

Any of these alloys can be used alone or in conjunction with from 1 to 2 parts of ferro-manganese. Of course other alloys or combinations can be used to give similar results. We have used the manganese-magnesium-silicon alloys No. 1 and No. 2 alone and in conjunction with equal parts of ferro-manganese and have not been able to observe much difference between the results with the different composition.

Ferro-manganese alone or with ¼ of a part of ferro-silicon gives good welds at times, but they are not as consistently sound and ductile as with the simultaneous use of some magnesium. The latter seems to be the essential part of the coating, and although the

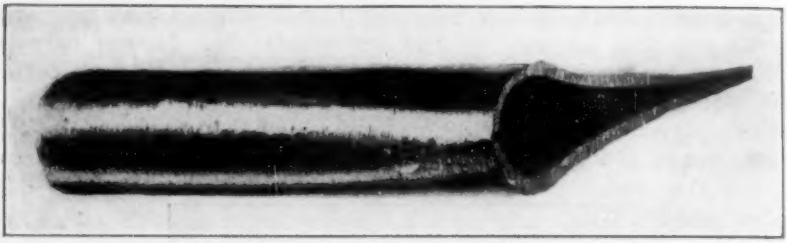


Fig. 3—Photograph showing bend in ⅛- arc-welded Monel sheet. This weld was purposely bent by way of test until it just cracked.

manganese and silicon aid in deoxidation and in producing proper fluidity of the molten metal,—and consequently a good weld surface, —they serve perhaps also in large part as a diluting carrier for the magnesium. The latter cannot be ground and is also too reactive to be used in the pure form as it oxidizes before it ever gets into the weld. The manganese and silicon act to protect it until it is absorbed in the molten weld. A nickel-magnesium, nickel-copper-

Fig. 4—Photograph showing bent in ¼" arc-welded Monel plate. This weld was purposely bent by way of test, until it just cracked.

magnesium or nickel-silicon-magnesium alloy of similar type could be used as well for magnesium carriers, as they are also brittle.

Some Tests of Arc-Welds

To illustrate the results we have obtained with the use of the type-deoxidizer described above, the photographs shown in Figs. 1 to 6 are presented. Particular attention is drawn to photograph No. 1, which shows the blow-holes generally encountered when welding even with the greatest care, but using bare or other wire without the deoxidizer coating. This should be compared with No. 2 in which a section is shown welded with the deoxidizer coating.

These welds are sound and practically as ductile as are welds on ordinary low-carbon steel. The photographs show cold bends of from 30 to 45° in ¼ in. Monel plate. Tensile tests carried out on 2″ and 3″ wide arc-welded strips of Monel Plate gave the following results, with which weld tests on the same material with the oxy-acetylene torch are given for comparison:

TENSILE TESTS OF ARC-WELDED AND OXY-ACETYLENE WELDED 3-INCH WIDE STRIP OF MONEL PLATE

Size Arc-welds, in.	Tensile Strength, pounds per square inch	Elongation in 2 in.	Fracture
.250 x 3	23,300	....	Ragged—two blowholes
.255 x 3	39,200	....	" —no "
.260 x 3	44,400	....	" —one blowhole
.245 x 3	47,800	....	" —four blowholes
.250 x 2	37,400	8.0	Irregular, slightly oxidized
.250 x 2	50,200	10.5	Ragged
.250 x 2	44,200	5.5	"
.250 x 2	55,500	11.0	Irregular shear
.250 x 2	65,000	12.5	Ragged shear
.250 x 2	60,500	9.5	Ragged
.250 x 2	48,800	8.0	"
.250 x 2	49,200	12.0	Sq. break
Average	47,100	9.70	
Oxy-acetylene welds, in.			
.250 x 3	44,600	10.5	Sq. tensile—two blowholes
.240 x 3	35,100	....	" " ragged—3 "
.235 x 3	45,500	8.0	" " —one blowhole
.230 x 3	50,500	9.5	" " —3 blowholes
Average	43,900	9.3	

Special Features of Arc-Welding Monel

Aside from the use of the special deoxidizer described above, arc-welding with Monel Metal is not essentially different in detail from that with steel.

With work ¼ in. thick and over, a 5/32-in. welding wire of Monel, for work from ⅛ to ¼ in., one of from 3/32 to ⅛ in. should be used, the best currents being 180-200 and 75-125 amperes respectively.

It is best to make the whole weld at one operation and not to build it up in successive layers, as the latter method will likely give

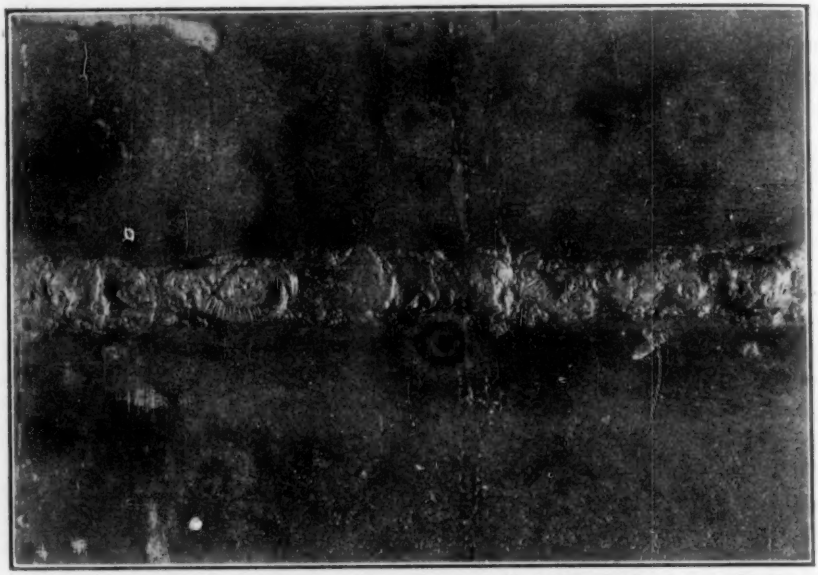


Fig. 5—Photograph of upper surface of arc weld (reduced about one third).

cracks and unsoundness. The weld should be well built up above the surface, as there are almost invariably small pinholes just under the surface of the weld, even with best welding practice.

An important variation from usual practice with steel is that of making the welding rod positive instead of the work. When the latter is made positive the metal tends to drop from the electrode and does not flow freely and continuously.

Fig. 6—Photograph of top surface of arc weld after burr has been ground flush and whole surface buffed and etched (reduced about one half).

In welding sheet, the usual angle should be left for shrinkage amounting to approximately $\frac{1}{8}$ in. per linear foot of weld.

The plate, rod or casting should be well cleaned of all scale by grinding or machining on both sides of the weld edge and it is well to coat these edges, by the use of a brush, with the same deoxidizer as is used on the rod.

Notes on the Occurrence and Influence of Non-Metallic Inclusions and Cavities in Electric or Oxy-Acetylene Deposited Metals†

By R. O. Griffis

Asst. Metallurgist, The American Rolling Mill Company

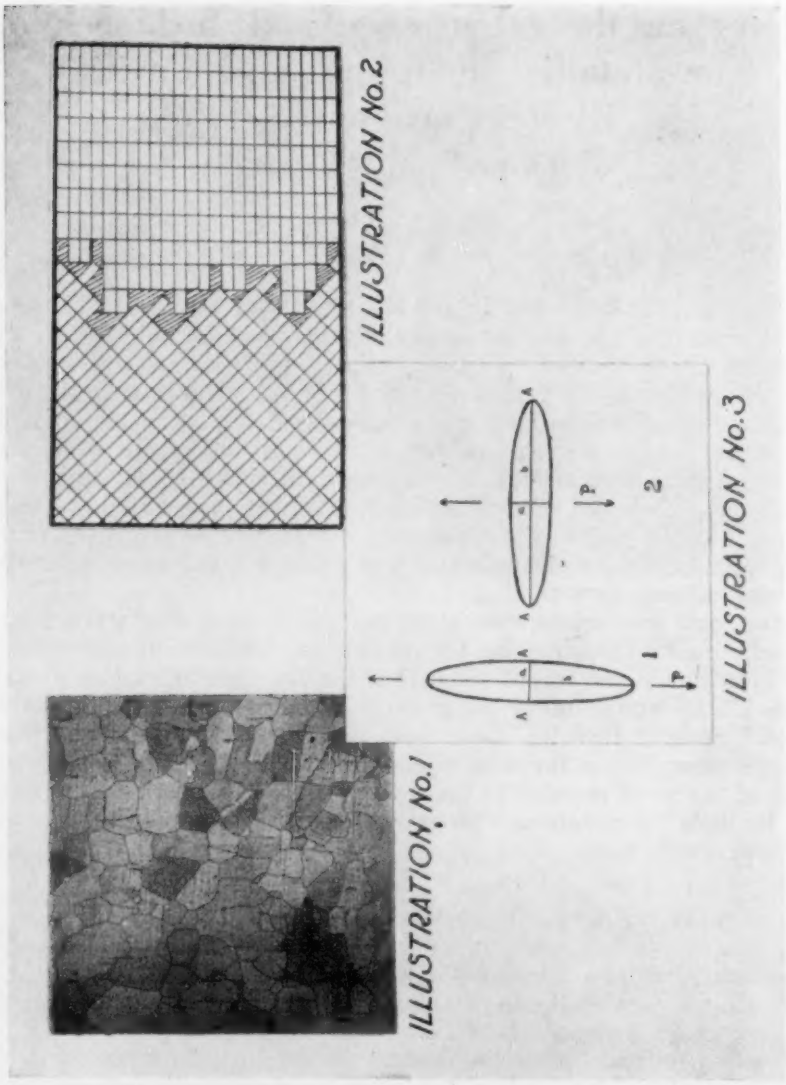
Non-metallic inclusions in any steel, whether cast, rolled, forged or deposited by the electric arc or oxy-acetylene flame have a very marked effect upon the physical properties of the metal. This is particularly true of the deposited metal of autogenous welds, where the strength of the welds depends almost entirely upon the amount of slaggy inclusions, gas pockets, or other imperfections in the weld. From a metallurgical viewpoint some of these imperfections are, of course, unavoidable, while others may be due to lack of skill on the part of the operator or to slag forming or gas-forming elements in the electrodes or gas-welding wires (such as manganese, silicon, carbon, etc.)

For some mysterious reason normal iron or mild steel when fractured, breaks through the ferrite grains, and not around them. At first glance one would think that the fracture of such material (See Ill. 1) would follow the grain boundaries, but such is not the case. Several theories have been put forward to explain this phenomenon, but so far none of the theories is entirely satisfactory. One of the most popular of these theories is Rosenhain's extension of Beilby's "Amorphous Cement Theory." Rosenhain writes as follows:

> "Where the constituent crystals of a metal meet, thin films of residual liquid (residual gamma iron in the case of steel) will remain under conditions rendering them incapable of crystallizing so that they constitute thin films of under-cooled liquid or amorphous metal acting as intercrystalline cement. . . . When two differently oriented crystals meet, there must be a region between the two orientations, where the material cannot assume the orientation of either. . . . The fundamental fact is the marked strength of crystal boundaries in pure metals."*

†Presented at annual meeting American Welding Society, April 27, 1922.

*A few words in explanation of this paragraph might not be out of place here. In the first place, iron is crystalline the same as alum, sugar, etc., and it crystallizes in the cubic system. This means that each of the grains (the areas enclosed by the narrow black boundaries shown in Ill. 1) is composed of myriads of minute cubes. And all the cubes in any one grain are lined up similarly, i. e., any face of any one of them is parallel to the corresponding faces of all the other cubes which go to make up that grain. This determines the "orientation" of the grain. The grains in a piece of iron have all possible orientations, like chunks of thick ice in an ice jam in a stream. Amorphous metal is metal which is not in a crystalline state.



Rosenhain's conception of how this takes place is represented graphically in Ill. 2.

But going back to where we were before we digressed, normal iron or steel, whatever may be the cause of it, is stronger at the grain boundaries than along the cleavage planes (planes parallel to the three sets of faces of the cubes). Whenever a film of brittle material, such as cementite or iron sulphide, exists at the grain boundaries the cohesion of the grains in the areas affected is destroyed and the strength of the material is affected in proportion

to the area occupied by the film. As mentioned above slags, gas pockets, voids and unwelded areas in a weld have an exactly similar effect.

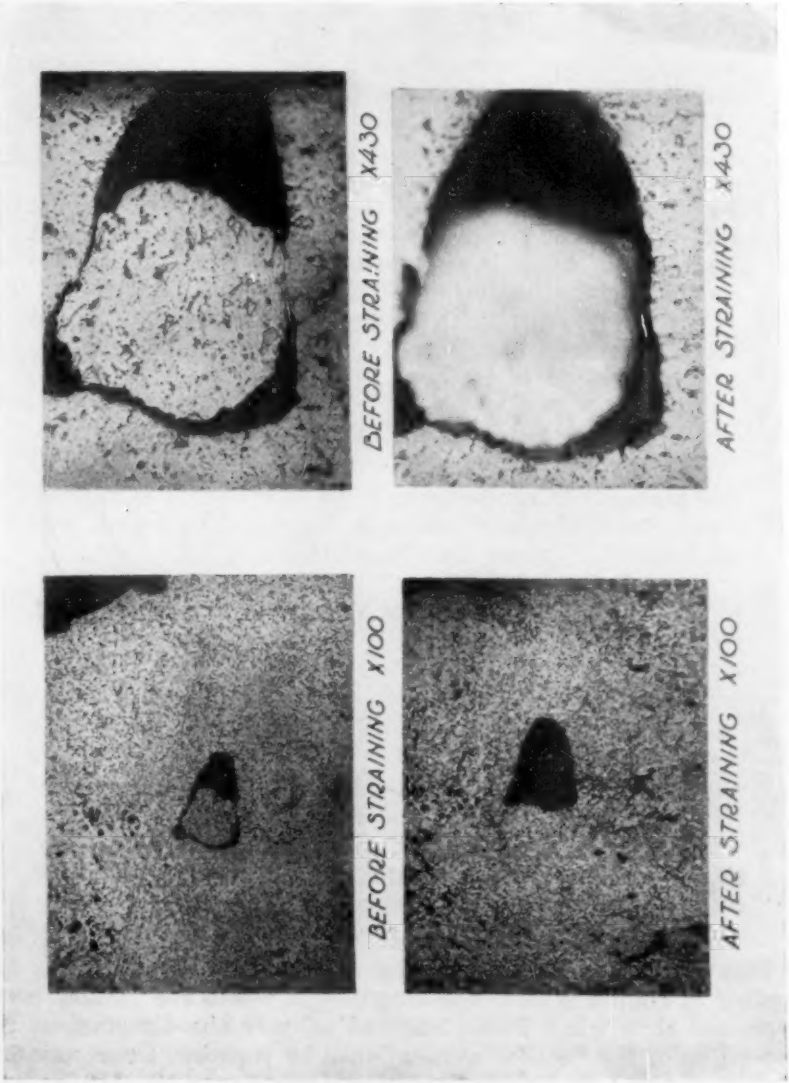


Plate I—Electrode Deposit.

McCance (Journal of the Iron & Steel Institute, 1918, No. 1, p. 240), in explaining why a steel containing inclusions when tested at right angles to the direction of forging showed physical proper-

ties far inferior to those obtained when tested parallel to the direction of forging, writes as follows:

> "In the first place they have acted simply as small areas of no strength which have lowered the effective area of the test piece, though this does not completely indicate their action. If a plate containing a hole is under tension the stress is not uniformly distributed, but is greater than the average at the edge of the hole.
>
> "If the hole is an ellipse with diameters *a* and *b*, the distribution of the stress round the edge depends in what manner the hole is situated relative to the applied stress, but it has been shown that if one of its axes lies along the direction of stress the maximum intensity occurs at the edges of the axis at right angles to this (Inglis, Proceedings of the Institution of Naval Architects, 1910).
>
> "In the figures (Ill. 3) the two positions are shown, and the maximum stress occurs in each case at A, and if the average tension is P, then
>
> $$\text{Stress at A} = P\ (1 + \frac{2a}{b})$$
>
> For purposes of comparison, if we assume that a crack in a piece of steel was elliptical in shape and its length was 20 times its diameter, then in position 1, I11. 3,
>
> $$P \text{ max} = P\ [1 + (2\ .\ 1/20)] = 1.1\ P,$$
>
> so that so long as it was pulled along its length there would be no great difference. But if it were pulled across this, as in position 2, I11. 3,
>
> $$P \text{ max} = P\ [1 + (2\ .\ \frac{20}{1})] = 41\ P$$
>
> and the stress at the end would now be 41 times greater. It can at once be understood how dangerous cracks are when pulled at right angles to their length, and why they extend and grow longer. And this is the most favorable case, because the ends of cracks are not rounded, but are sharp, which entails a still greater difference."

This explains very simply why some electric arc deposits are weaker at right angles to the direction in which the "beads" were deposited than when tested longitudinally to the direction of the deposition of the "beads" as mentioned by Rawdon, Groesbeck and Jordan (Bureau of Standards, Technologic Paper No. 179, p. 23). The same also applies to oxy-acetylene deposited metal. The thin layers of slag between successive depositions of metal would naturally occupy a greater portion of the cross section of the specimen when the "beads" cross the test specimen at right angles to its longitudinal axis.

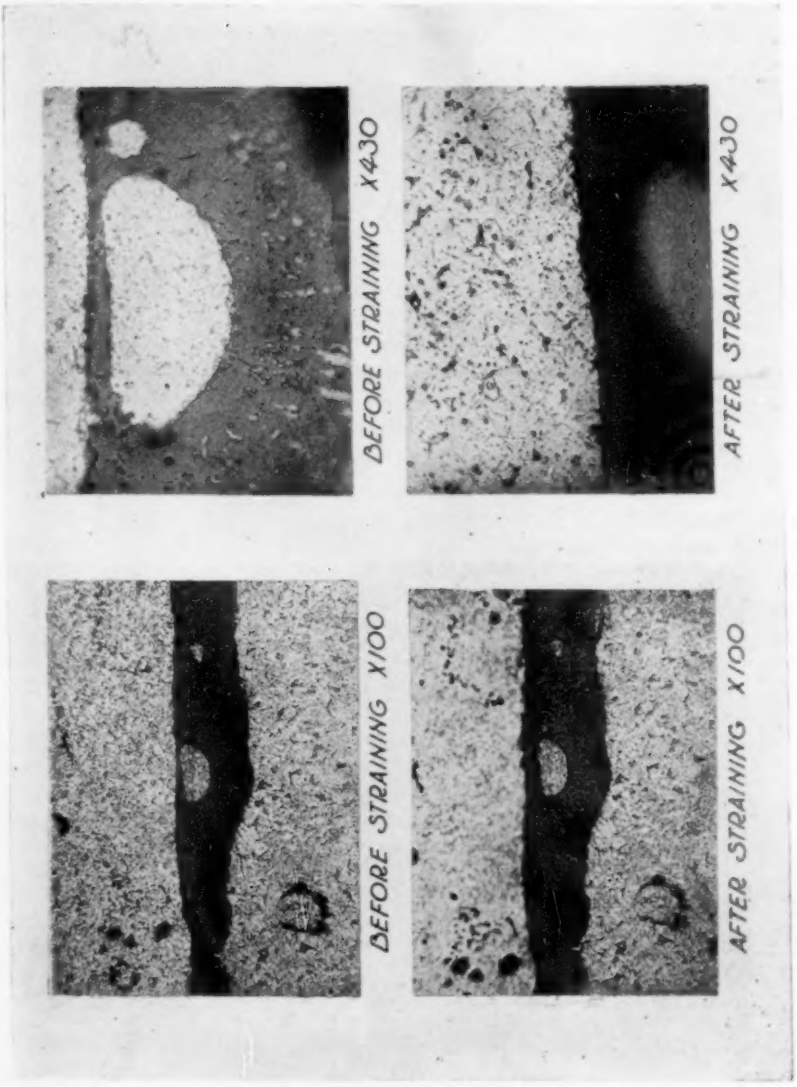


Plate II—Electrode Deposit.

In addition to the layers of slaggy material between the "bead" layers slag is found in the form of globules distributed somewhat promiscuously throughout the mass of specimens deposited by the electric arc. The interiors of these globules are filled with metal. This particular form of inclusion is well known and is shown in the four micrographs on Pate I. The micrograph at 100 diameters, Plate No. II, also shows several globules of this kind. A defect of this kind would not weaken the deposited metal to the same degree

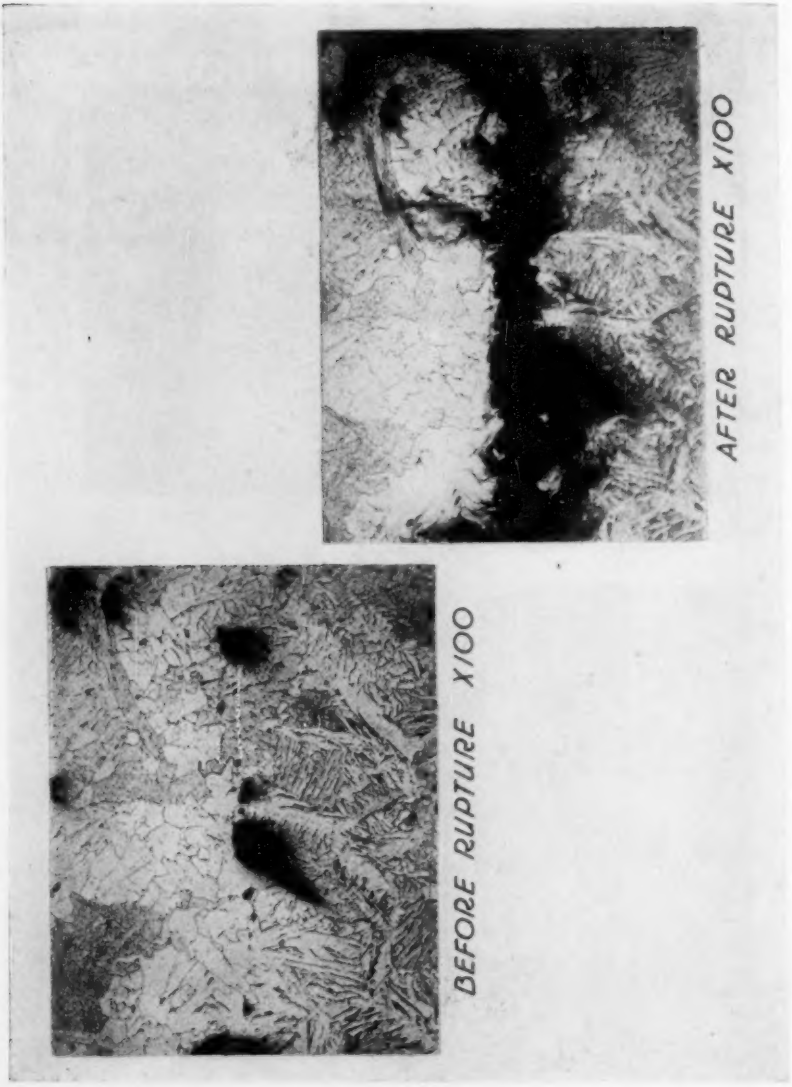


Plate III—Gas Weld.

as a gas pocket or void of the same shape, on account of the "propping" action of the solid interior preventing the collapse of the walls and thus distributing the stressess more evenly in the case of the globule. This "propping" action of the inclusion itself was overlooked by McCance and his equations are therefore not exactly applicable to solid inclusions, but only to cracks and voids.

The micrographs shown in Plates I and II were made from a specimen of metal deposited by the electric arc. The appearance

of two areas, selected to show the two general types of slag inclusion, are shown at magnifications of 100 and 430, before and after straining beyond the elastic limit. The specimen was strained in comparison. A comparison of the micrographs of the slag streak at 430 diameters, before and after straining will show that the metal has faulted, as shown by the fact that the globule of metal in the slag just beneath the crack is not in focus. It will also be noted that the globule of metal mentioned has been shifted to the right roughly two-thirds of its length. All this distortion was effected without any deformation of the metal in the immediate neighborhood of the slag streak, as shown by the absence of slip bands. In other words, the specimen was so weakened by the presence of its slag layer that the metal faulted and shifted in the manner described without being strained beyond its elastic limit. However, an examination of the micrographs of the globule, after straining, shows the presence of many slip bands. The metallic interior of the globule has been forced outward by the compression.

Plate III shows the characteristic appearance of an oxy-acetylene weld before and after fracture. The upper half of each of the micrographs shows the deposited metal and the lower half the welded material, the latter showing the characteristic appearance of such metal heated to an extremely high temperature and cooled rapidly.

The micrographs shown in Plates I and II represent metal deposited by the electric arc and not an actual weld. Those shown in Plate III represent an oxy-acetylene weld and the fracture in this case occurred on the tension side of a bend test. It will be seen that the fracture followed along the string of slag inclusions and gas pockets.

The recommendations that can be made in the light of our present knowledge of deposited metal are briefly as follows:

1. In gas welding extreme care should be taken by the operator to float out the slag and, obviously, to guard against imperfections due to the deposited metal not "biting" into the welded material; and in electric welding the same degree of care should be taken in freeing from oxide the layer of metal first deposited before depositing the succeeding layer.

2. Care should be taken to maintain as short an arc as practicable, so that undue oxidation of the electrode may be avoided.

3. The welding wire or electrode should be chosen on a basis of freedom from slag forming elements, such as silicon and manganese, so that the amount of slaggy constituents formed may be held at a minimum.

4. The carbon content of the welding wires or elec-

trodes should be held at a minimum. This is very important, as under the oxidizing conditions of either gas welding or electric welding the carbon combines with oxygen to form carbon monoxide. The pockets formed by the entrapping of this gas in the deposited metal are very detrimental.

5. Uniformity of welding material should be insisted upon as it is of very great importance. Uniformity enables the welder to make good welds consistently and helps to eliminate the human factor, which, under the most favorable conditions is an important factor in oxy-acetylene or electric welding.

MEMORANDUM

ELECTRIC WELDING IN JAPAN*

H. J. Cox†

Regarding the general application of electric welding in Japan I am not yet in a position to write, but in the shipyards and ship repair plants the art has established a quite definite footing and is generally considered as an important, if not indispensable, factor in the industry.

The Japanese are well known for their keenness to assimilate any new ideas or methods adopted by their competitors in the West and electric welding has been no exception in this respect. They have applied themselves seriously, not only to the practical development of its application in the field, but also to laboratory research work. It is now the exception to come across a shipyard or repair plant without one or more electric welding units as part of the equipment.

Both physically and temperamentally the average Japanese artisan should make a good welder; he is relatively small of stature, steady, and can squat compactly beside his work for hours at a stretch without becoming cramped. By temperament he is patient, conscientious in his work, and precise, and has not yet acquired the habit of rushing things, which is so often responsible for defective welding.

In the shipyards here I have seen the Quasi Arc, Kjellberg and Lincoln systems in use, while some yards simply use the bare wire electrodes with control devices designed and equipped by themselves.

The Mitsubishi Zosen Kaisha (shipbuilding company) have now

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*Presented at the February, 1922, meeting of the Philadelphia section of the American Welding Society.

†Acting Principal Surveyor in Japan for Lloyds Registry.

been exploring and developing the use of electric welding in ship construction and ship and engine repair work for some years, and are probably in the forefront of the industry in this country in it's application at the present time. This company have three large shipbuilding and repair plants at Nagasaki, Kobe and Hikoshima respectively, in all of which electric welding is now largely employed, the Kjellberg system of coated electrodes being used.

Under the direction of Dr. Haramiishi, general manager of the Kobe plant, and one of the leading authorities on electric welding in Japan, this company has turned out a number of interesting and successful examples of electrically welded structures, such as a floating dock gate for a 465-ft. dry dock, and a vertical donkey boiler (in both of which electric welding was largely used in lieu of riveting). They have also converted the steam trawler *Dairyo Maru* into a vegetable oil barge, using electric welding entirely in the conversion, and on completion tested the tanks with an 8-ft. head of water. The barge has proved quite satisfactory in service during the past two years.

At the Kobe plant about 20 welders are employed, the shipyard and boiler shop welders being separate departments, each specializing in their own work. Both at Kobe and Nagasaki they have established training schools where new hands are trained for a period of about six months in the various kinds of electric welding, and before being put on actual work of any importance specimens of their welding must satisfactorily pass a series of physical tests. A good average welder is paid at the rate of approximately $1 a day, i.e., at the same rate as the ship fitters.

In Tokyo this company has a well-equipped physical research laboratory where they are carrying out extensive research in connection with electrodes, eye protection, methods of inspection and testing, etc., under the direction of Dr. Suyehiro, one of the leading physicists in Japan. Important results have already been achieved in the development of a metallic coated amber glass giving a high degree of visibility with safety, also in the production of electric welds in a hydrogen flame.

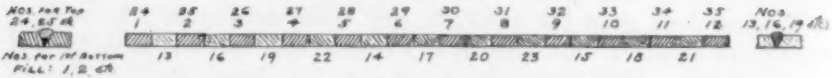
An interesting example of welding relatively large areas of plating has just been completed by this company at Kobe in the construction of an all-welded floating crane pontoon, a brief description of which, together with some of the practical conclusions arrived at, may be of interest.

The hull is 65 ft. long, 35 ft. molded breadth and 8 ft. molded depth, and the form is rectangular in cross section and deck plan, with the bottom plating at both ends curved upwards with a 2-ft. 6-in. radius. The plating is ¼ in. and 5/16 in. in thicknss, all the joints being butt welded. This plating is stiffened by flat bar frames 3½ in. x ⅜ in. spaced 30 in. apart and tack welded, while the whole structure is suitably braced by fore and aft and thwartship bulkheads.

The construction was arranged to avoid overhead welding as far as practicable. For instance, large areas of deck plating with beam stiffeners attached were welded on the ground upside down and then placed in proper position and welded to the frames and bulkheads.

Several methods were tried to avoid warping of the plates and the internal strains due to shrinkage when making a long seam weld, and the method found to be most economical from point of speed was as follows:

DIAGRAM OF WELDING PROCEDURE



After placing the plates to be welded so as to allow for a creeping of 1/8 in. to the running foot, light or initial layer welds are made about 8 in. apart along the entire seam. The operator then makes a complete weld between the first two tacks, then omits three spaces and makes a complete weld between the fifth and sixth tacks and so on until the end of the seam is reached. This process is repeated again by starting between the second and third initial tacks and so on until the complete seam is welded. Finally the finish or second layer welds are made on the initial light tacks, so completing along the entire seam. This method appears to have given the best results in regard to dissipation of heat and elimination of internal stresses and buckling.

When large areas of plating were being welded together into position it was impossible to entirely avoid buckling, and it is interesting to note that an experienced *coppersmith* was employed on this work, who, as a result of his training, was able to decide just to what extent and in which direction a cut should be made in the surfaces by the oxy-acetylene flame to relieve the stress, when the buckle could be faired and the cut re-welded.

Owing to the elimination of overlaps, connecting angles and flanges, liners and rivet heads, the following savings over a similar rivetted structure were estimated:

Overlapping of plates at joints	4%
Angle connections and flanges	9%
Liners	1%
Rivet heads	2%
Total	16%

In addition to which the welding eliminated the following labor: Mold loft work, laying out of shapes and plates, punching, reaming, drilling, rivetting and caulking, while the transportation and handling of steel was considerably reduced.

Although a saving in caulking was claimed, it might be mentioned in passing that all of the water-tight seams or joints in this barge were carefully hammered over with a 2-lb. hammer as an additional safeguard for water-tightness.

The average speed for double bevelled, butt joint, flat welding, in straight runs on the 1/4-in. or 5/16-in. plating assuming a nine-hour working day was as follows:

One welder and one assistant—18 ft. per man per day (including hammering).

One welder and one assistant—45 ft. per man per day (no hammering).

The distribution of total cost of welding, including the supply of electrodes, electric current and labor was found to be as follows:

16 per cent for electric current consumed.
32 per cent for wages paid.
52 per cent for cost of electrodes.

Some experiments were recently carried out by this company to determine the effect on high tensile steel of electrically welding attachments to it (i.e., the effect on high tensile steel due to the heat set up) as compared with the effect of holes punched for rivetted attachments. The results showed that the ultimate strength is not greatly reduced from that of the original steel, but the percentage of elongation is considerably reduced, although not so much as by the punched holes.

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Acetylene Welding. H. Küntzel, Autog. Metallbearb. (March 1, 1922). Vol. 15, pp. 63-6.

Production of high pressure acetylene by means of oxygen. Die Acetylenhochdruckerzengung durch Sauerstoff.

Arc Welding Railway Shops. S. E. Mason. Electric Railway Journal (March 18, 1922). Vol. 59, pp. 446-8. A table giving articles reclaimed and saving per month by the San Antonio Public Service Company on their rolling stock.

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gineering. Vol. 35, No. 3, March, 1922, pp. 62-64. Details of approved methods of selecting material and perfecting repairs. Welding of complete fireboxes, preparing halfside and door sheet for welding, firebox sheet, knuckle patch, repairing small portions of side sheet, welding patch on front of crown sheet, welding of seams, broken mud ring, improper welding of firebox plates.

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The Making of Joints in Seamless Steel Tubing. C. N. Waterhouse. Acet. and Weld. Jnl. (Feb., 1922). A series of tests on the oxy-acetylene process applied to the tubular metal structure of airplanes.

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Welding and Reclaiming Worn Brake Heads. Electric Traction. Vol. 18, No. 4, April, 1922, p. 325. Johnstown Traction Company saves many brake heads that would ordinarly be scrapped.

NEW HAND BOOK

The Page Steel and Wire Company has just issued a new hand book on the "Page Armco Welding Wire and Electrodes." This pamphlet contains history and manufacture of Armco Iron, elimination of oxygen, microphotographs, diameter of rods to be used with different thicknesses of plate. Metallurgy of iron and steel and useful physical tables and information.

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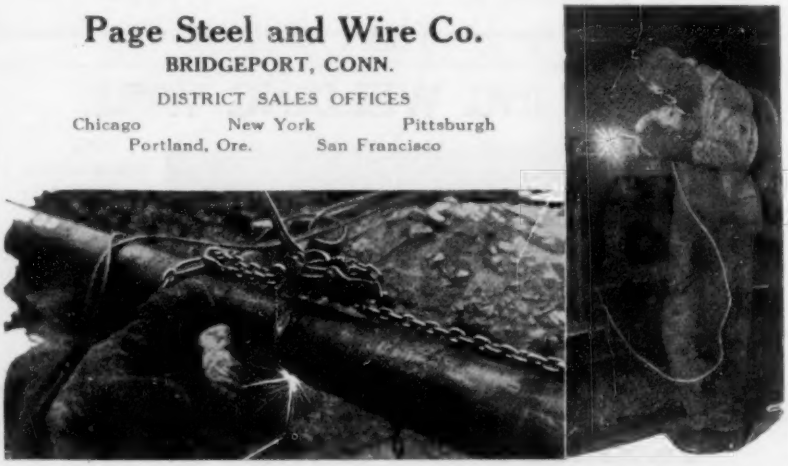

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